REMARKS

Claim 31 has been amended to overcome the objection to its informality.

Claim 32 has been amended according to the Examiner's suggestion to overcome the rejection under 35 U.S.C. §101. Claims depending from claim 32 have also been amended accordingly where necessary, and to clear up discrepancies in dependencies.

CLAIM REJECTIONS – 35 U.S.C. §101

Claims 1, 8 and 13 have been rejected on the basis that they are directed to non-statutory subject matter, namely algorithms which are not tangible results.

Claim 1 has been modified to add the step of training the adaptive model with the selected vectors. This is a well-recognized useful result in that such models are useful as described in the specification for monitoring equipment health, among other things. Selection of training data is a critical aspect of achieving a useful model, as indicated both in the present application, as well as references cited by the Examiner, i.e., Passera, col. 3. lines 1-20. Claim 1 is a method claim, the result of which is useful, and therefore should be in form to overcome rejection under 35 USC 101. Claim 1 is not a mere algorithm.

Claim 8 is an apparatus claim, for an apparatus for monitoring a system instrumented with sensors, and has been amended to tie together the functions of the elements. It has a recited empirical modeling module for providing indications about the operational states of the monitored system, which is a useful result. Indications may comprise health indications, operational diagnoses and the like, as described in the specification. The apparatus of claim 8 also includes the training module for selecting training data according to the invention, which

selected training data is stored in the data store, and made available to the empirical model for training and generating the empirical model. The claim as now amended is clearly not an algorithm, nor is it non-statutory subject matter.

Claim 13 is a method claim that recites forming an empirical model for monitoring system operation by selecting training vectors to comprise the model according to the invention. Applicants strongly contend that rejection under 35 U.S.C. §101 of this claim is inappropriate, and claim 13 is not an algorithm, any more than any method claim is an algorithm. The result of the method of claim 13 is useful empirical model.

CLAIM REJECTIONS – 35 U.S.C. §103

The general bases for the obviousness rejections of the present office action involve the combination of four or more references, and in some cases combined with the Examiner's official notice as to what is common knowledge. It serves the purpose of clarity to discuss several of the main references first and their general combinability before looking at the individual claims.

Black et al., is directed in part to industrial equipment monitoring, and in particular to the use of an empirical model of equipment operation for comparison to actual measured signals to provide sensitive detection of anomalies. Applicants agree with the Examiner that this reference is relevant, since this is the very field of the invention. Applicants agree that Black et al., shows generally the need for down-sampling the available reference data during training to form a "prototype matrix", a problem that is also solved in a particular way by the present invention. However, Black et al. teach a hyperbox clustering technique and selection of a representative vector closest to the centroid of each cluster as the means of training. This is performed once in n-dimensional space as opposed to with respect to each variable, and assumes the data will cluster meaningfully. This contrasts with the present

invention wherein no clustering is performed, and wherein vector selection is performed for each identified driver variable independently.

Freund, et al., "Statistical Methods", is a textbook on general statistics, used to support the teaching of stratified sampling. The definition referred to by the Examiner states: "Stratified sampling is a sampling method in which the population is divided into portions, called strata, which are expected to contain relatively homogeneous units, and samples ... are taken independently in each stratum." First, it is not obvious to combine Freund with Black because Freund is not in the area of system modeling for monitoring purposes. Furthermore, Freund is not related to the industrial arts such as sensor calibration, which is the subject of Black et al. One skilled in the art working in the area of Black et al., and trying to solve the training problem for empirical modeling, would not be any more inclined to refer to Freund than any other textbook in all of mathematics, and would probably be less inclined to do so since Freund is not directly related to equipment monitoring. Moreover, the chapter of Freund relied upon is "Sampling and Survey Samples", which is completely different from modeling, regression and the like, which the Examiner points to as the basis for combining Black and Freund.

Second, what Freund teaches is not the same as what is claimed in the present invention. Stratified sampling by definition presumes the data samples can be grouped into strata that "contain relatively homogeneous units", i.e., are common in some way. This is analogous to clustering, except that each stratum must have a common element. This is not the case in the present invention, where the available reference vectors are not grouped or clustered, but are ordered according to a sensor value continuously. Thereafter, intervals are introduced which result in a sampling pattern that appropriately selects interstitial vectors for more dynamic regions. In ordering the vectors, they are not being clustered or grouped in common ways, but

instead may very well present a uniform spectrum of variation. Furthermore, it is claimed in the present invention to perform this method iteratively for multiple variables, such that the selection of vectors for inclusion in the resulting training matrix is done independently for possibly several variables, which would not make any sense if one were practicing the stratified sampling of Freund. As pointed out in Applicants' response to the Examiner's previous office action with regard to reference Guiver, the present invention contrasts with multidimensional clustering (and likewise with stratified sampling) in that the sampling can be tuned for each of several variables independently, which is not possible in clustering or stratified sampling. Therefore, not only would it not have been obvious to refer to the teachings of Freund and combine them with Black, what Freund teaches is not what is claimed in the present invention.

Passera is directed to empirical models and explaining the causality of model behavior, and is relied on for reference to stratified sampling as a training method for empirical models (Col. 3, lines 3-19). However, no details about the method of stratified sampling are provided. Furthermore, as described above, stratified sampling does not carry out the steps of the present invention. Passera is relied on also for the teaching of computer readable program code. Passera is further relied on for teaching identification of dominant driver parameters (col. 2, lines 1-13). However, in fact Passera is concerned with a slightly different issue, which is the sensitivity of the model in different subspaces of the input space, all of which are in the n-dimensional space of the data vectors. Passera teaches a determination of what modes of system behavior exist in possible subspaces, which modes may be more sensitive to particular variables. The variables that matter in one subspace may be different than those that matter in another subspace. In the present invention, dominant drivers of the system are identified (whether from an

analytic method or from a priori knowledge) in order to determine vector selection according to that variable using the binning method of the invention, which is not the described in Passera. Passera does not use information regarding importance of variables to determine how to train an empirical model, but rather uses variable sensitivity in certain subspaces to explain model behavior. Therefore, Applicants contend that Passera's teaching in this respect does not make identification of driver variables for purposes of training obvious.

Rubenstein is a textbook on simulation and Monte Carlo methods. It is relied on for the teaching of sampling according to importance, (p121-122, section 4.3.1). Applicants contend Rubenstein does not make any of the claims of the present invention obvious in combination with Black, however, for several reasons. First, Rubenstein, like Freund, is unrelated to equipment monitoring and appears to be a general, theoretical textbook. One skilled in the art would not be particularly disposed to refer to Rubenstein, especially for the teaching relied upon. Second, the section relied on concerns importance sampling for purposes of estimating integrals, which is different from the purpose of modeling in the present invention. Further, the importance sampling distribution $f_X(x)$ (where x is an n-dimensional vector) results in more or less a clusterizing approach in n-dimensional space as opposed to the approach of the present invention, which provides for vector selection on the basis of individual variables iteratively. It is also noted by the Applicants that section 4.3.4. of Rubenstein, relating to stratified sampling, is also a multidimensional approach dissimilar to the approach of the present invention, and fundamentally amounts to clusterized sampling. Rubenstein shows in detail a method for optimally determining the number of samples to select from each cluster based on the cluster size and cluster variance, which is not the method of the present invention, regardless of whether under certain circumstances and with particular

datasets, the vector selection results of the present invention and the vector selection results according to Rubenstein would appear qualitatively similar. According to the method of the present invention, a determination is made as to which variables are more important, and then vector selection based on an ordering of the vectors according to the values of those important variables is performed at higher density, resulting in better characterization of the n-space in the dimension of the important vectors. This is *not* the same as clusterizing in n-dimensions and sampling from each cluster. Therefore Rubenstein, like Freund, does not make the present invention obvious both because it is not related art, and because what it teaches is not what is claimed in the present invention.

It is worth clarifying that the approaches of stratified sampling and importance sampling are not the same as what is claimed in the present invention, and referred to as binning. The term binning as used by the Applicants is described in the specification at paragraph 0055 of the published version of the present application, and comprises setting intervals to equally divide the Y-axis. Binning is therefore not the same as clustering or stratifying according to some homogeneous quality attributable to the data. And because the binning is occurring in a particular dimension, which may be designated a more important dimension and therefore sampled at a higher bin number (larger number of intervals, therefore larger number of selected vectors), it is different from importance sampling, which is multidimensional. In importance sampling, *regions* of n-space (the regions *D* according to Rubenstein) are deemed "important" and sampled from accordingly, whereas in the present invention, *dimensions* are deemed important and vectors are selected more densely along that dimension according to its areas of variability (see FIG. 5 of the present application).

Claims 1-21, 25-28, 31-37, 50 and 51 are currently pending, and all stand rejected for obviousness on the basis of Black et al. and Freund in combination, and in view of other references. Claims 1, 8, 13, 26, and 32 are the independent claims.

Claim 1 is not obvious in view of the combination of the references, because the stratified sampling of Freund does not make the claim obvious, as described above with regard to the discussion of Freund (and also incidentally Rubenstein). Neither stratified sampling nor importance sampling for that matter are being practiced in this claim. Specifically, the claim calls for ordering the vectors according to the value of a particular value (dimension, element, etc.), and then creating equally spaced intervals in that dimension in order to select representative vectors from each interval. The intervals do not have homogeneous characteristics, and are along one dimension of the data only. This is not the case in Freund (or in Rubinstein). One skilled in the art looking to Freund would conclude that the data vectors must be grouped according to some common attribute (location, gender, etc., common to demographics), or in the closest sense at least clustered. Clustering is not occurring in Claim 1. Furthermore, vectors are not being selected with greater density *within* any given interval, which is the implication of the teachings of Freund and Rubinstein (importance sampling). Rather, more vectors are being selected overall according to this claim, where the variable according to which the vectors have been ordered exhibits *greater* variability (less homogeneity).

Claim 8 is likewise not obvious from any combination of the references, for the same reasons as claim 1. In claim 8, regularly spaced intervals along an ordering according to one of the variables is different from the clusters or strata of Freund (or Rubinstein).

Claim 13 is similarly not obvious in view of any combination of the references. Claim 13 refers to "binning" the ordered vectors, which means with reference to paragraph 0055 of the specification (in the published version of the application) dividing the y-axis into equally spaced intervals. Just like claim 1 and claim 8, this is not done according to the teachings of Freund and Rubinstein.

Applicants contend claim 26 is also not obvious in view of any combination of the cited references, where binning can be understood as specified in paragraph 0055 of the specification to mean dividing the y-axis (the value axis) for a given variable (element) of the vectors into equally spaced intervals. The sorter sorts or orders the snapshots responsive to a selected system parameter, and the vector selector applies the equally spaced intervals forming the bins from which the vectors are then chosen. As discussed in detail above, this is different from what is taught in Freund (and Rubinstein).

Claim 32 is likewise not obvious from any combination of the cited references for the same reasons as recited for the other independent claims above. Claim 32 provides for ordering the vectors according the value of a particular variable, dividing them into equally spaced intervals (along the direction of the ordering) and selecting vectors from the intervals. This is different from Freund and Rubinstein. Again, the vector ordering does not necessarily create clusters or strata with homogeneous qualities, nor regions of importance, and vector selection is not being practiced in such a manner.

Dependent claims are more specific than the independent claims they refer to, and because the independent claims are not obvious, the dependent claims are likewise not obvious in view of the cited references.

CONCLUSION

In view of the foregoing, Applicants respectfully request reconsideration and allowance of this application. More specifically, independent claims 1, 8, 13, 26 and 32 and their respective dependent claims, are respectfully submitted as being in condition for allowance.

Respectfully submitted,

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